

Case Study: New Use Development Site

Sampling Strategies and Data Analyses For A Redevelopment Project

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New Use Development Site

Given Facts:

- NUD acquired a vacant 2-acre parcel formerly occupied by Acme Widgets.
- NUD intends to redevelop the property for residential uses.
- NUD hired Really Good Consultants, Inc. to perform assessment of the property.
- Groundwater at site is not in an aquifer and no GSI concerns exist.
- Visually discernible fill is present on portion of site, but underlying soils are clean.

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Site Assessment Findings:

- Screening of soils in vicinity of old floor drain discovered during demolition of the building revealed Trichloroethene (TCE) impacts. Impacted soils were previously sampled and removed by Acme. No information re: source of TCE is available.

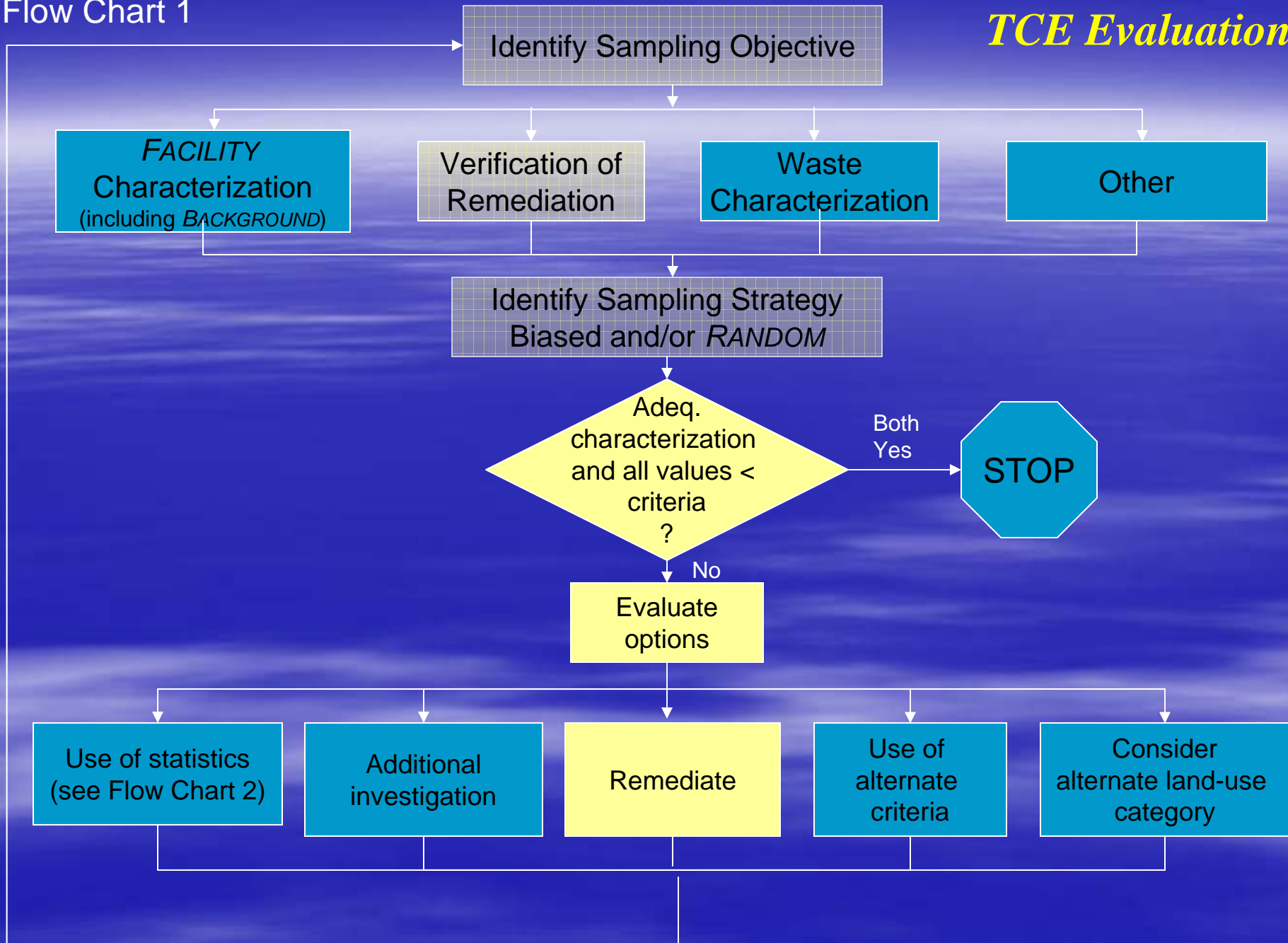
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Site Assessment Findings:

- Data from post-excavation sampling in TCE release area show three samples exceed SVIIC criterion (7100 ug/kg). RGC states that additional removal and sampling will be performed in the TCE *RELEASE* area.

Flow Chart 1

TCE Evaluation



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Site Assessment Findings:

- Initial soils sampling shows benzo(a)pyrene (BAP) present in fill over approx. ½ of the site (top 6 in. to 1 ft.).
- Levels below soil residential direct contact criterion (2000 ug/kg) at all locations except Location 4.
- Average BAP level (1000 ug/kg) for 2 acres was calculated using ½ detection limit for samples that were ND.
- Average is below criterion.

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RGC concludes that data show that all BAP releases have been addressed and the site meets Part 201 Generic Residential Criteria.

Question: Can we agree?

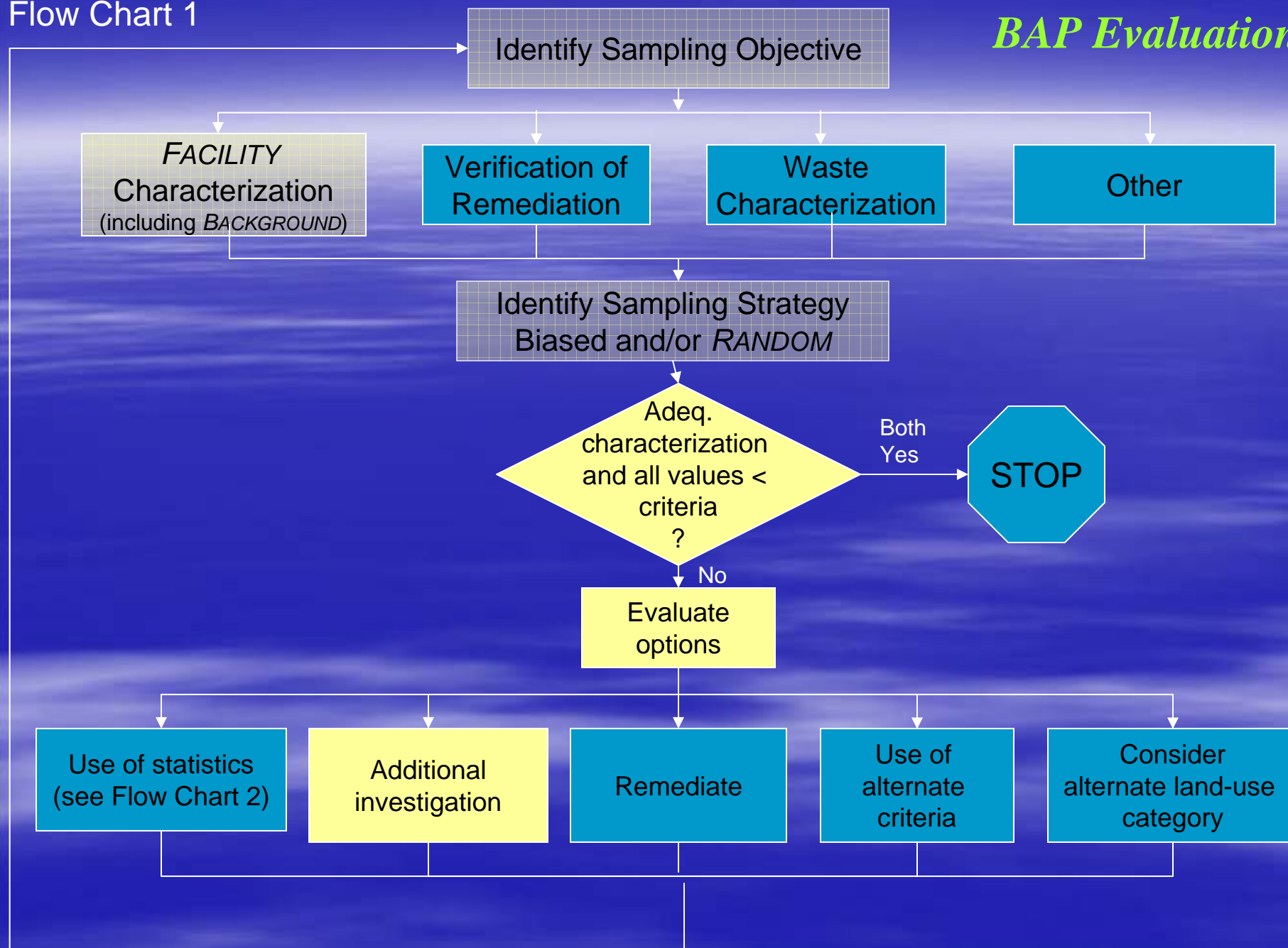
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Answer: Not yet! Here's why:

- Fill Area:
 - Not adequately characterized: only 8 samples for 2-acre site. Possible BAP *HOT SPOT* at Location 4.
 - Extent of BAP appears confined to fill portion of site, but need to confirm boundary.
 - Use of average for BAP value inappropriate.
 - Site characterization inadequate (*HOT SPOTS?*).
 - *EXPOSURE UNIT* (EU) too large.
 - Should estimate *REPRESENTATIVE CONCENTRATION* using a 95% upper confidence limit for the mean.

Flow Chart 1

BAP Evaluation



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Our Recommendations:

- Fill Area:
 - Evaluate Location 4 for possible BAP *HOT SPOT* by stepping out with additional samples.
 - Perform additional biased sampling along apparent boundary of fill to confirm.
 - Perform additional sampling in fill area to adequately characterize BAP and identify other potential *HOT SPOTS*.
- TCE *RELEASE* Area:
 - Excavate further and provide additional verification data.

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RGC performs soils removal and additional sampling at site. Supplemental information provided:

- Post-removal sampling of TCE *RELEASE* area shows all samples below criterion.
- Verification sampling was conducted in accordance with Section 1.3.1 of Sampling Strategies (see S³TM).
- Stepping out around Location 4 with 16 samples confirms 50' diameter BAP *HOT SPOT*.
- 4 additional samples along fill area confirm BAP impacts limited to fill materials.
- Note: All comparisons to criteria have been point-by-point thus far.

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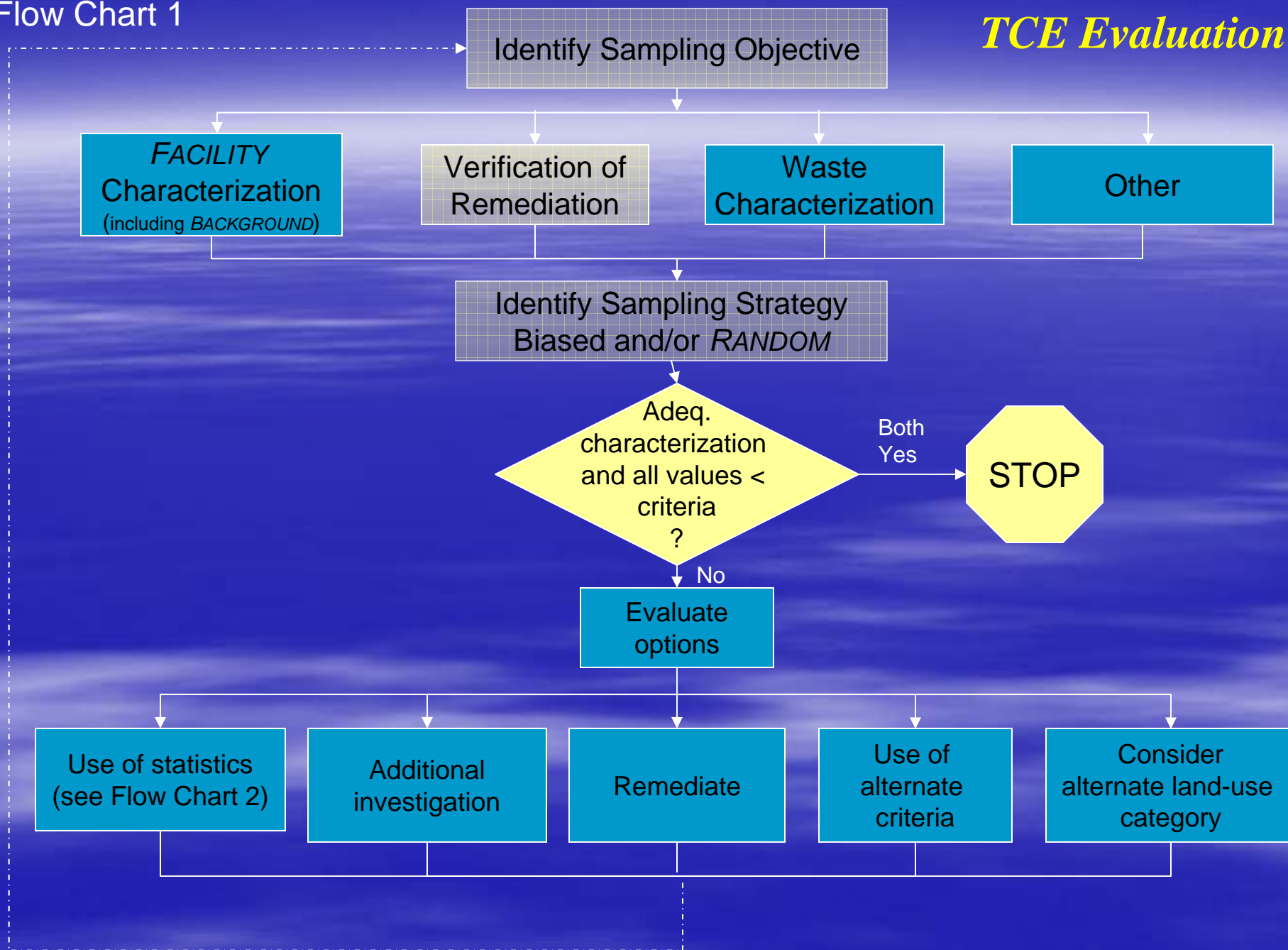
RGC Recommendations:

- No further investigation of TCE *RELEASE* area necessary.
- Presence of unexpected BAP *HOT SPOT* makes careful evaluation of confirmed fill area necessary. RGC proposes:
 - 1) capping of *HOT SPOT* and
 - 2) sampling of fill area using a 20' systematic *RANDOM* grid to allow detection of 25' diameter *HOT SPOTS*.

DEQ concurs and RGC proceeds.

Flow Chart 1

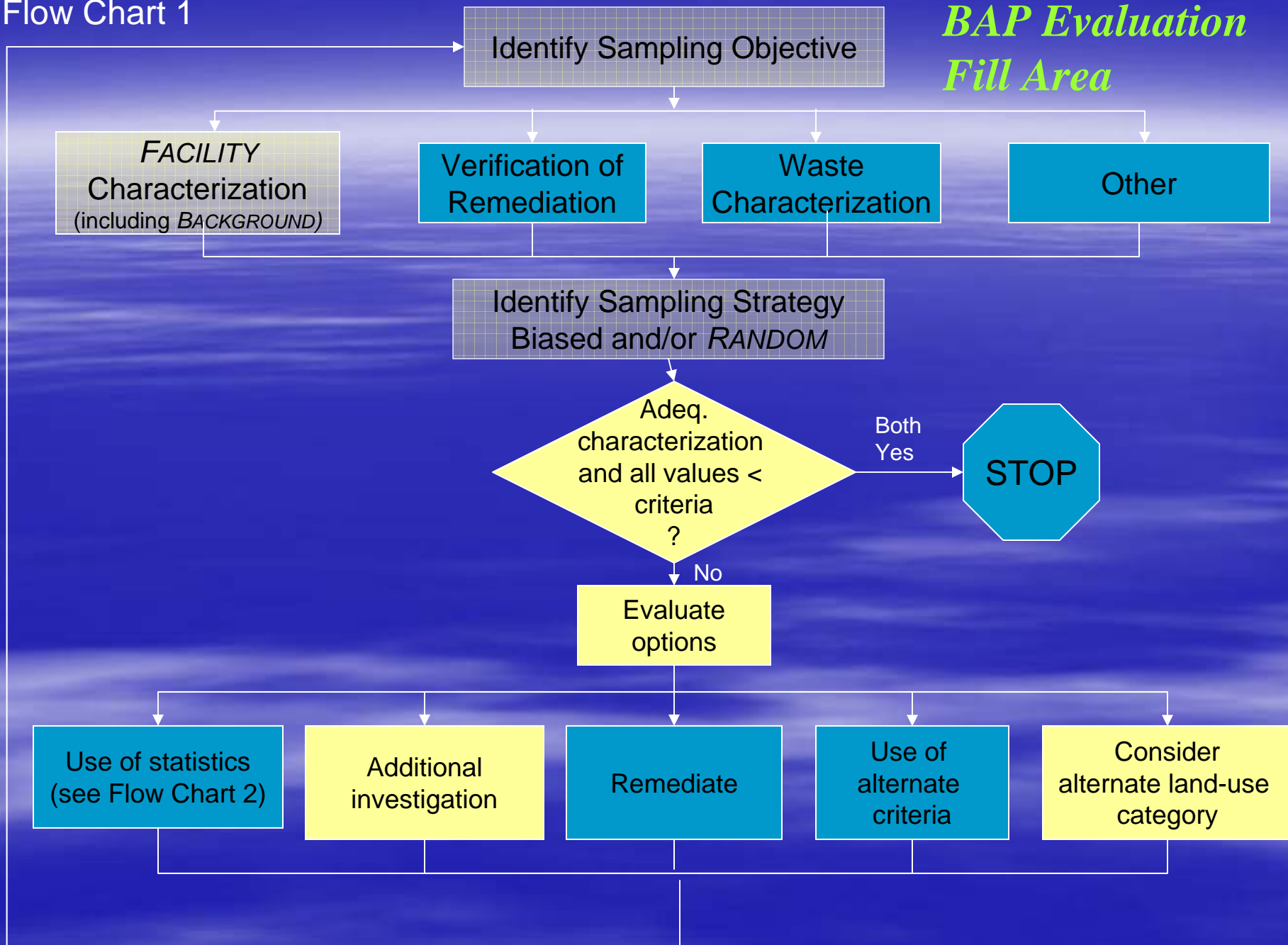
TCE Evaluation



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Flow Chart 1

BAP Evaluation Fill Area



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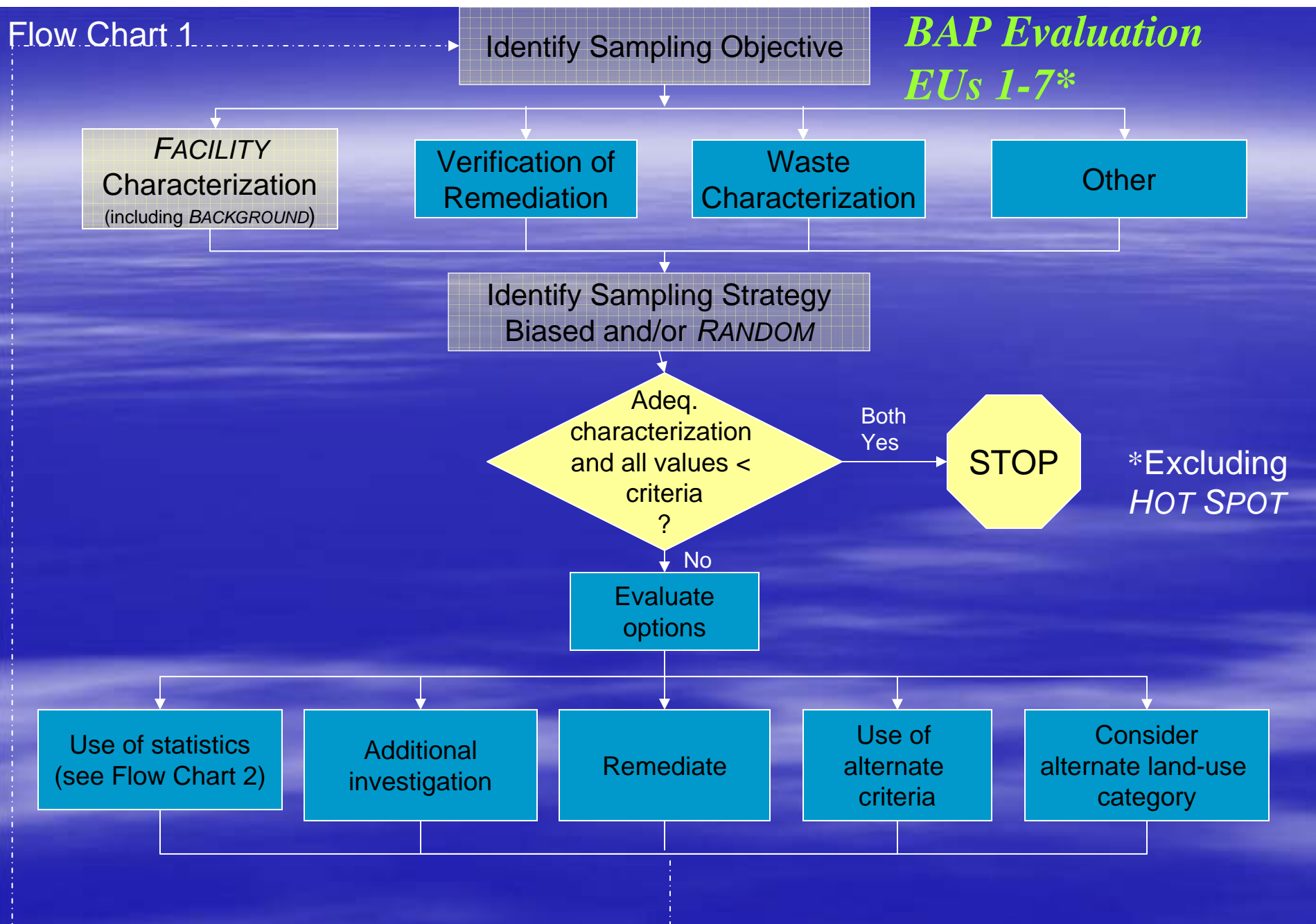
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RGC submits report which shows:

- Grid sampling shows all points < criterion except Location 133 @ 3000 ug/kg.
- Location 133 evaluated by stepping out. Data show no *HOT SPOT*.
- Upon defining ¼-acre *EXPOSURE UNITS* (EUs), EUs 1-7 < criterion except *HOT SPOT* at location 4.
- BAP concentrations in EU8 must be further evaluated.

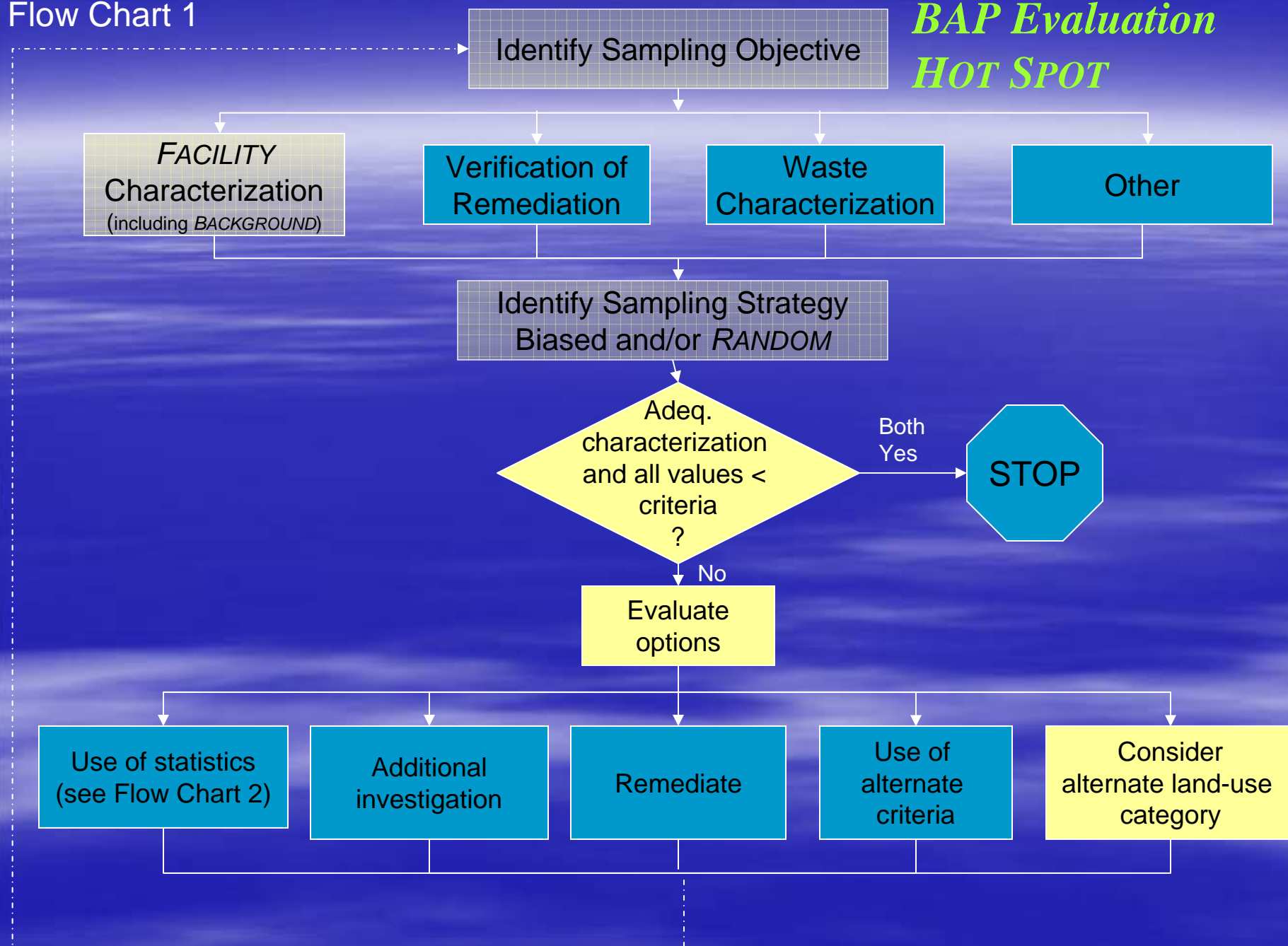
Flow Chart 1

***BAP Evaluation
EUs 1-7****



Flow Chart 1

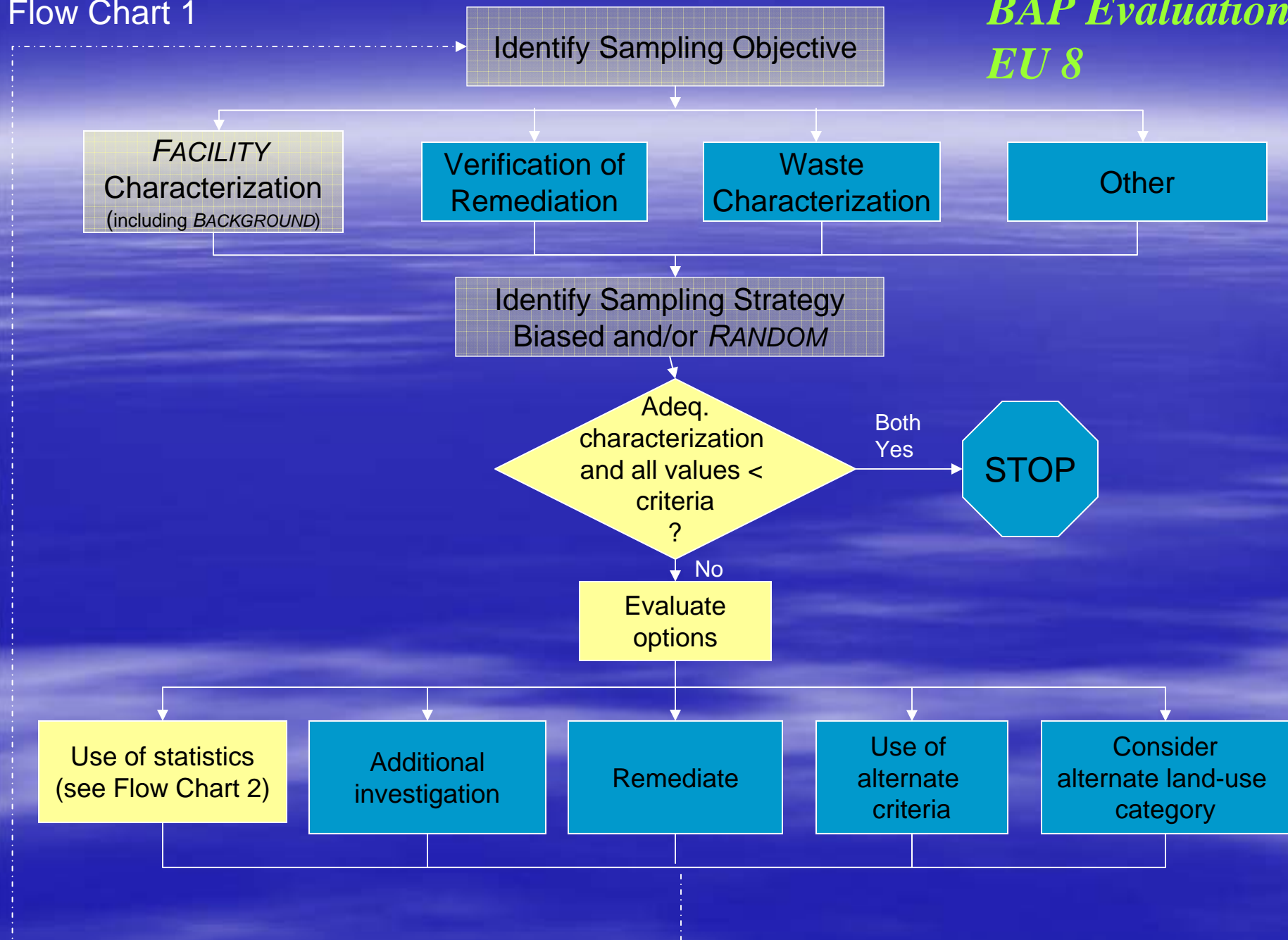
***BAP Evaluation
HOT SPOT***



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Flow Chart 1

BAP Evaluation EU 8



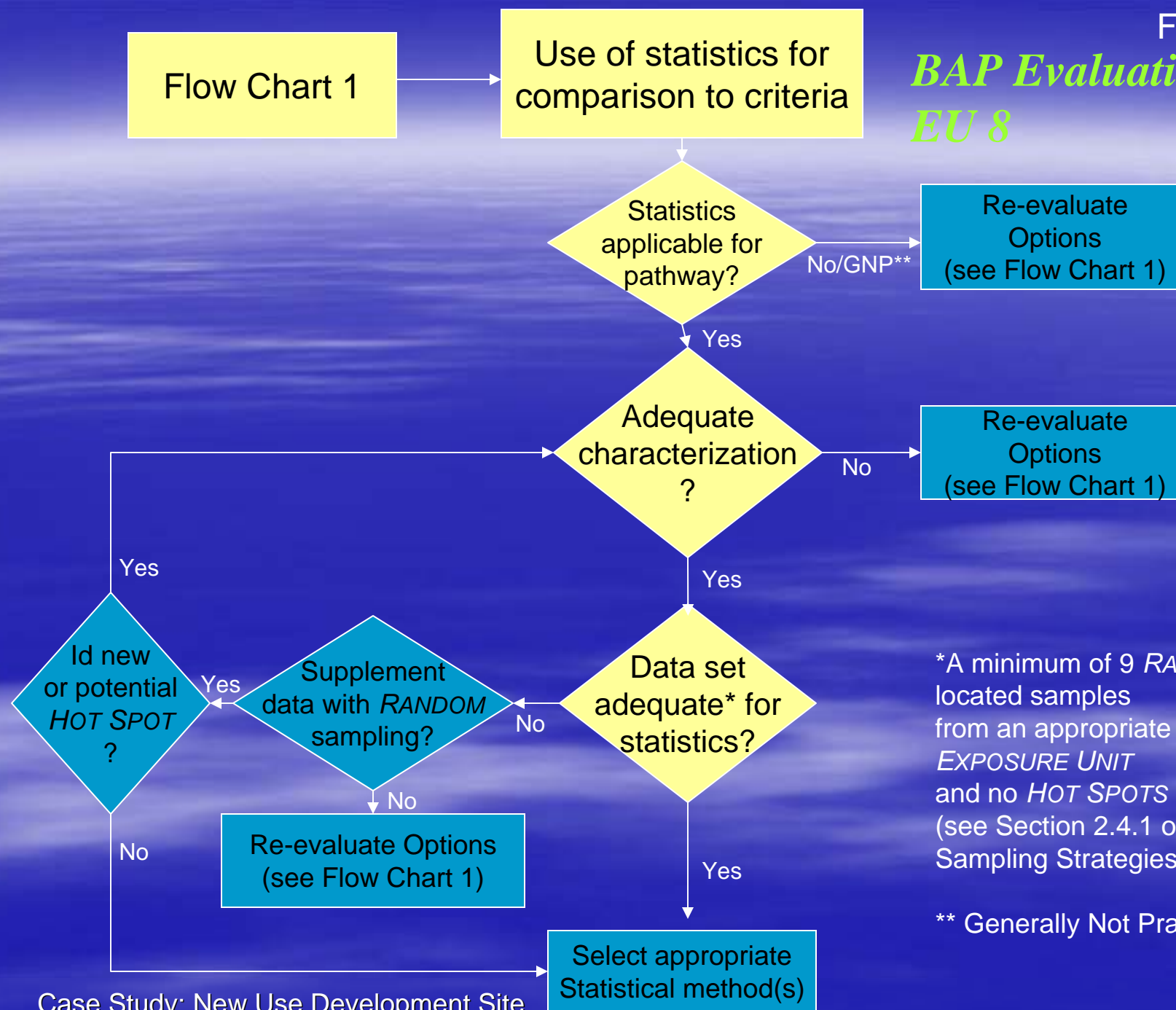
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What next?

- Evaluate use of statistics to demonstrate compliance with residential soil DC criterion of 2000 ug/kg in EU8.

BAP Evaluation *EU 8*



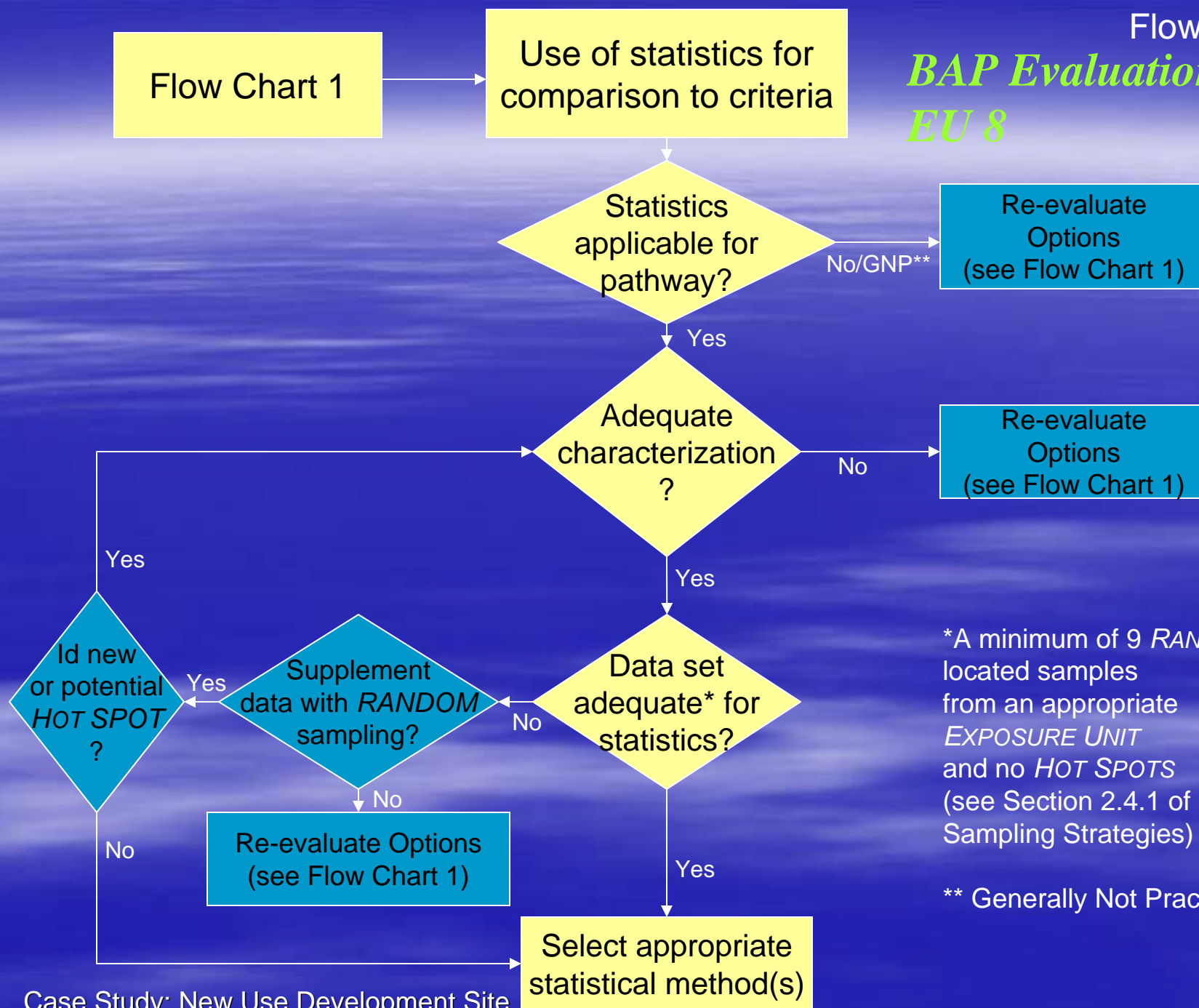
*A minimum of 9 *RANDOMLY* located samples from an appropriate *EXPOSURE UNIT* and no *HOT SPOTS* (see Section 2.4.1 of Sampling Strategies)

** Generally Not Practical)

New Use Development Site

- Adequate data set?
 - YES.
 - Minimum of 9 *RANDOM* samples (n=25).
 - From an appropriate *EXPOSURE UNIT* (for generic residential soil DC criterion, ¼-acre).
 - No *HOT SPOTS* identified.
 - Since location 133 (3000 ug/kg) was not a *HOT SPOT*, include in the statistical analysis to derive a *REPRESENTATIVE CONCENTRATION*.
 - Do not include step out samples around location 133.

BAP Evaluation *EU 8*



*A minimum of 9 *RANDOMLY* located samples from an appropriate *EXPOSURE UNIT* and no *HOT SPOTS* (see Section 2.4.1 of Sampling Strategies)

** Generally Not Practical

New Use Development Site

Ready to upload...

	A	B	C
1	Area	BAP (ug/kg)	BAP (ug/kg).nondetect
2	EU8	700	0
3	EU8	900	0
4	EU8	730	0
5	EU8	430	0
6	EU8	440	0
7	EU8	590	0
8	EU8	910	0
9	EU8	810	0
10	EU8	750	0
11	EU8	460	0
12	EU8	330	1
13	EU8	1500	0
14	EU8	1000	0
15	EU8	750	0
16	EU8	330	0
17	EU8	1800	0
18	EU8	780	0
19	EU8	410	0
20	EU8	1200	0
21	EU8	520	0
22	EU8	520	0
23	EU8	430	0
24	EU8	3000	0
25	EU8	700	0
26	EU8	410	0

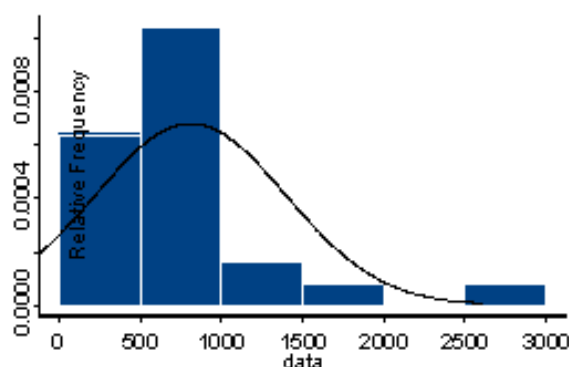
BAP concentrations in EU8, ug/kg

Statistical Interface for Part 201 Evaluations

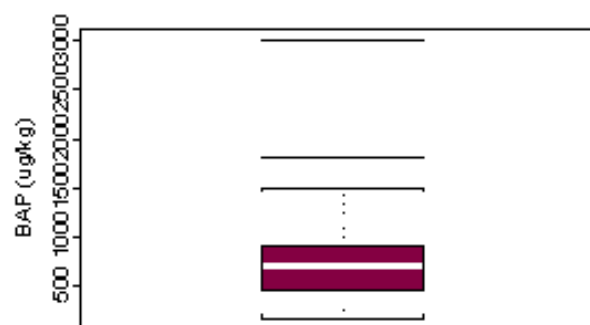
Normal Distribution Analysis for BAP (ug/kg)

Data Set Name: Exercise 4

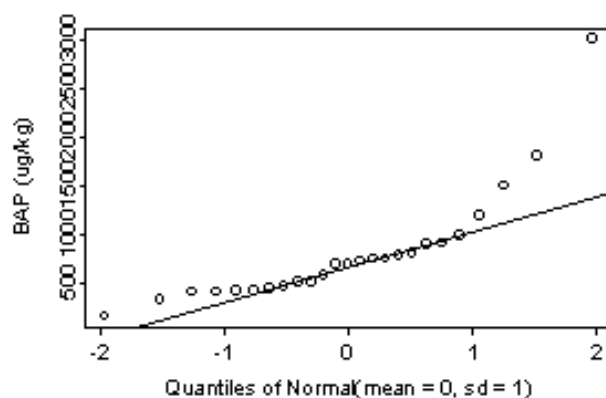
Histogram of Observed Data
with Fitted Normal Distribution



Box Plot of BAP (ug/kg) Data



Normal Probability Plot of BAP (ug/kg) Data



Summary Statistics

Sample Size:	25
Coefficient of Variation:	0.723422
Coefficient of Skewness:	2.353798

Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 809.4 sd = 585.5381
Test Statistic:	W = 0.7428002
Test Statistic Parameter:	n = 25
p-value:	2.905827 e-5

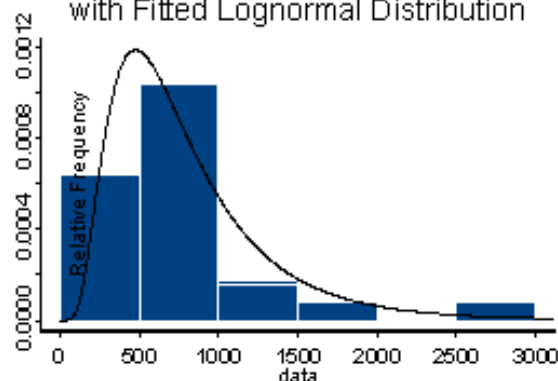
Since $p < .05$ conclude distribution is not normal.

Statistical Interface for Part 201 Evaluations

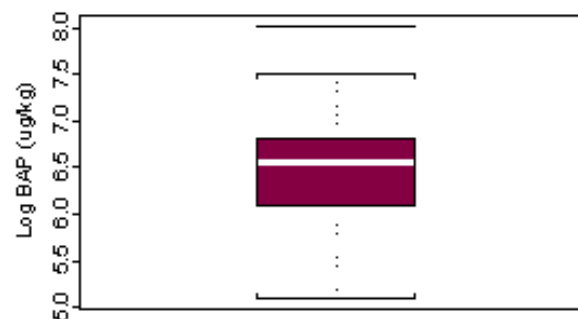
Lognormal Distribution Analysis for BAP (ug/kg)

Data Set Name: Exercise 4

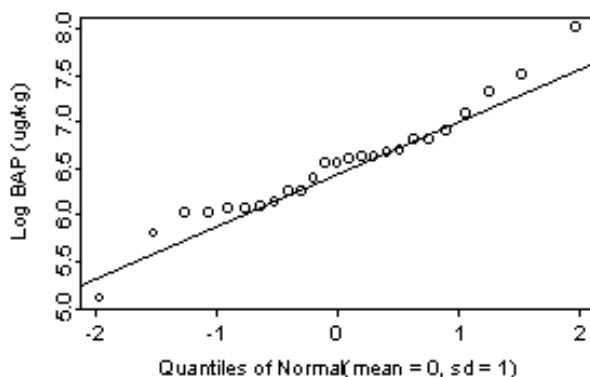
Histogram of Observed Data
with Fitted Lognormal Distribution



Box Plot of Log BAP (ug/kg) Data



Normal Probability Plot of Log BAP (ug/kg) Data



Summary Statistics

Sample Size:	25
Coefficient of Variation:	0.09108
Coefficient of Skewness:	0.2635762

Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Lognormal
Estimated Parameters:	meanlog = 6.515647 sdlog = 0.5934455
Test Statistic:	W = 0.9655081
Test Statistic Parameter:	n = 25
p-value:	0.534591

Since $p \geq .05$ conclude distribution is lognormal.

Statistical Interface for Part 201 Evaluations

Outlier Analysis Results

Test	Sample size	Suspect	Test statistic	Conf. level	Critical value	Conclusion
Grubb's Test	25	8.006	2.512	0.95	2.663	Suspect observation is not an outlier.



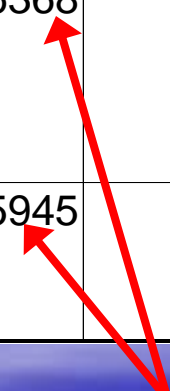
Natural log (ln) of highest value

Note: Grubb's Test was used here to test for a single, high outlier.

Statistical Interface for Part 201 Evaluations

Outlier Analysis Results

Test	Sample size	Suspect	Test statistic	Conf. level	Critical value	Conclusion
Rosner's Test	25	8.006368	2.512	0.95	2.82	Not an outlier
Rosner's Test	24	5.105945	2.609	0.95	2.8	Not an outlier



Natural logs (ln) of highest and lowest values

Note: Rosner's Test was used here to test for two outliers: one high and one low.

Statistical Interface for Part 201 Evaluations

Upper Confidence Limit Analysis Results

Label	Value
Assumed Distribution:	Lognormal
Data:	BAP (ug/kg)
Sample Size:	25
Confidence Interval Method:	Land
Confidence Level:	95%
Upper Confidence Limit for the Mean:	1031.8

The 95% UCL for the mean (1031 ug/kg) < 2000 ug/kg. Conclude the mean concentration in EU8 is less than the generic residential soil DC criterion.

New Use Development Site

Conclusions:

- TCE *RELEASE* area has been adequately characterized and remediated.
- Characterization of BAP on 2-acre property is adequate.
- 50' BAP *HOT SPOT* at location 4 to be capped. Changes remedy from generic to limited.
- All other BAP concentrations in EUs 1-7 meet DC criterion of 2000 ug/kg on a pt-by-pt basis.
- Statistical analysis demonstrates that the mean BAP concentration in EU8 is below 2000 ug/kg.

New Use Development Site

Soils Waste Classification

Jack Schinderle

New Use Development Site Soils Waste Classification

Knowns:

- Soils impacted by TCE.
- Source of TCE unknown.
- Concentration in one floor sample (prior to additional excavation) was 11000 ug/kg (Figure 7).
- Exceeds 20 X RT (10000 ug/kg).

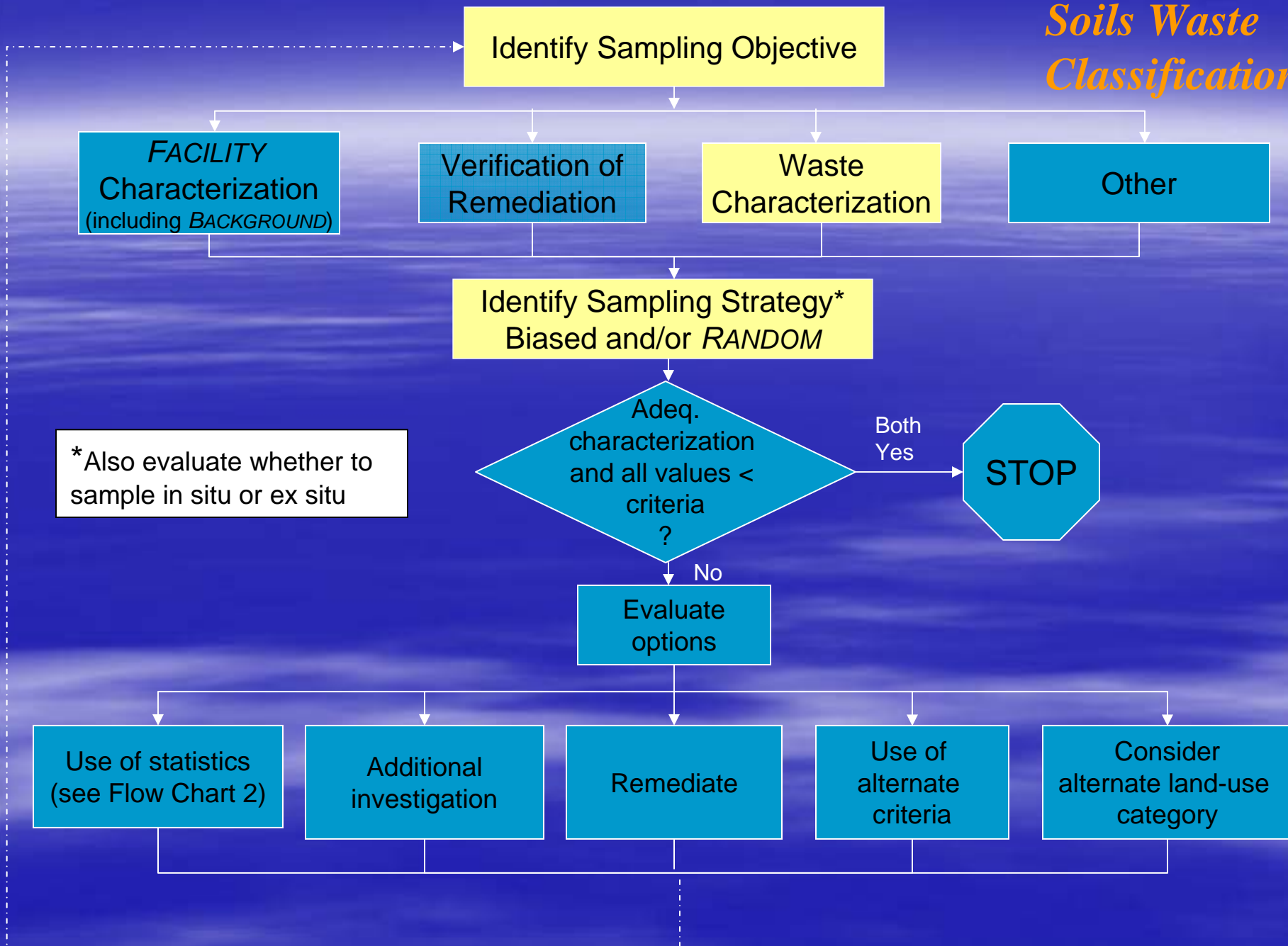
New Use Development Site Soils Waste Classification

- Source Unknown.
 - MDEQ files.
 - Manifest Records.
 - Other Historical Information.
- Source cannot be linked to a HW listing.
- Does not require management as listed HW.

New Use Development Site Soils Waste Classification

- Not listed - Look at Characteristics.
- TCE > 20 X rule of thumb.
 - 20 X RT for materials that are 100% solid.
 - Assumes leaching at 100%.
- Existing verification data not adequate to determine (Figure 7).
 - Not representative of the excavated soil.
 - Number.
 - Location.
- Further analysis required.

Soils Waste Classification



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New Use Development Site Soils Waste Classification

- Further sampling and analysis in situ.
 - Run TCLP on original sample > 20 X RT (if possible).
 - Run TCLP/Totals on new samples from location over 20 X RT (Figure 7).
 - Failure: *RANDOM* sample and stats.
 - Totals and/or TCLP.
 - Small site grid = 12 samples (Section 1.3 of Sampling Strategies).
 - Failure:
 - Define extent of hot area and remove as HW, or
 - Collect additional samples (sample size formulas, Section 3.2 of Statistical Methods section of S³TM)

New Use Development Site Soils Waste Classification

- Sampling and analysis ex situ.
 - Biased sampling and point-by-point comparison.
 - Totals and/or TCLP.
 - 8 samples based on volume (Section 2.1.2 of Waste Characterization).
 - *RANDOM* samples and stats.
 - Totals and/or TCLP.
 - Small site grid = 12 samples (Section 2.2.2 of Waste Characterization).
 - Failure: Manage as Hazardous Waste.

New Use Development Site Soils Waste Classification

- What if the contaminants were linked to a listed source?
 - Soils would be managed as listed waste under the contained-in policy.
 - Type B criteria for soil is 44 ug/kg.
 - Verification samples exceed 44 and would be managed as HW when generated/excavated (Figure 8).
 - Prudent to place notice in deed, but not required.

New Use Development Site

Work Group Exercise

Evaluation of Remedial Alternatives

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Summary:

- TCE *RELEASE* area was adequately remediated by excavation and collection of verification samples.
- Characterization of BAP on 2-acre property is adequate.
- 50' BAP *HOT SPOT* at location 4 to be capped. Changes remedy from generic to limited.
- All other BAP concentrations in EUs 1-7 meet DC criterion of 2000 ug/kg on a pt-by-pt basis.
- Statistical analysis demonstrates that the mean BAP concentration in EU8 is below 2000 ug/kg.

New Use Development Site

Question:

Are there any other approaches that could have been used at this site?